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GROWTH AND PRODUCTIVITY OF GROUNDNUT (*Arachis hypogaea*) UNDER DIFFERENT TILLAGE AND SOWING METHODS IN INDIA

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ABSTRACT

A field experiment was conducted during *rabi* seasons of 2009-10, 2010-11 and 2011-12 to assess the effect of 3 tillage practices (conventional tillage, no tillage and rotavator tillage) and 4 sowing methods (conventional sowing, seed-cum-fertilizer drill sowing, paired row sowing and criss-cross sowing) on groundnut production. Tillage methods showed no significant difference in pod yield with maximum yield in rotavator tillage treatment (1570 kg ha^{-1}). Amongst the sowing methods, paired row sowing gave significantly highest pod yield and net returns (1781 kg ha^{-1} and ₹19730 ha^{-1}, respectively). The interaction between tillage practices and sowing methods was non-significant. The study revealed that none of tillage practice effectively enhanced yield, however paired row sowing proved superior in pod yield with 15.6, 22.2 and 25.4% increase over seed-cum-fertilizer drill, criss-cross sowing and conventional sowing methods, respectively. Paired row sowing also improved various yield associated attributes *viz.*, number of pegs (35.1) and pod plant^{-1} (27.6), shelling percentage (66.6) and 100-kernel weight (33.6 g), and profitability (₹19,730) in groundnut.

Key words: Groundnut, planting methods, pod yield, productivity, tillage

INTRODUCTION

Groundnut (*Arachis hypogaea* (L.) Merrill is cultivated in tropical and sub-tropical countries. India is the largest producer of groundnut which is predominantly grown in the states of Andhra Pradesh, Gujarat, Tamil Nadu, Karnataka, Odisha, Maharashtra, Madhya Pradesh and Rajasthan. These states contribute >95% of total area and production in groundnut. Odisha stands 5th in production having 2.54 lakh ha under the crop and annual production of 4.32 lakh tonnes with average productivity of 1699 kg ha^{-1}. The crop is mainly grown in *kharif* under rainfed conditions. However, in eastern India especially Odisha, the cultivation of *rabi* groundnut is picking up. The groundnut seed is valued both for its oil and protein contents. In Odisha groundnut oil is popularly used for cooking purpose. Tilling of soil has been considered as one of the important soil management practice adopted for ensuring proper soil health. For optimum germination and growth, the soil must optimally supply water, oxygen, nutrients and heat; additionally the soil must be loose enough to allow root penetration and seedling emergence (Gupta and Abrol, 1993). Tillage not only improves looseness, oxygen supply and water intake but also influences soil bulk density,

penetration resistance and intake, storage and extraction of soil water by plant roots and microbial activity which, in turn, influence aeration, moisture and temperature of soil (Khan, 1984).

The tillage equipment may cause soil compaction and upset the balance between air and water components of soil. The compaction caused due to tillage implements may increase the soil strength and restrict root growth (Patil *et al*., 2010). However, a slight compaction is needed to gain good contact between seed and soil particles. This can be achieved by adopting well planned tillage practice and appropriate sowing method that create congenial soil environment, which is particularly necessary for seed germination and effective plant growth. Appropriate method of sowing has several advantages like better inter-culturing, weeding, uniform irrigation, management of insect, pest and disease and mechanical harvesting (Rabo and Ahmed, 2013).

Groundnut is usually sown in flat beds at a spacing of 30 cm x 10 cm for bunch groundnut in post-rainy season. Generally farmers use country seed drills for seed sowing. For large scale sowing, tractor-mounted seed drills are used in major groundnut areas. Change in the direction of sowing reportedly increases groundnut yield by 18% as compared to normal sowing in post-rainy season (Basu and Ghosh, 1996). Farmers are switching over to paired row method of sowing (20-30-20 cm) which increases pod yield by 28%. Paired row of 20-30-20 cm (spacing within pair 20 cm and between pairs 30 cm) x10 cm showed significantly maximum pod yield (2254 kg ha^{-1}) and net return (₹7105 ha^{-1}) with a benefit cost ratio of 3.30 (Devi Dayal *et al*., 1992). Minimization of inter-plant competition due to uniform distribution of seed in paired row method might be responsible for yield improvement. In order to give an insight in to the profitability of groundnut production, the present study was undertaken to assess the effect of tillage practices and sowing methods on growth, yield and economics of *rabi* groundnut.

MATERIALS AND METHODS

The experiment was conducted at Breeder Seed Production Farm, OUA&T, Bhubaneswar (India) for 3 consecutive *rabi* seasons of 2009-10, 2010-11 and 2011-12 in a split plot design with 3 tillage treatments (conventional tillage, no tillage and rotavator tillage) in main plot and 4 sowing methods (conventional sowing, seed-cum-fertilizer drill, paired rows and criss cross sowing) in sub-plot replicated 3 times. The experimental site was located at 20.15°N latitude and 85.53°E longitude with average annual rainfall of 1520 mm. The soil was medium deep with pH 5.9, available N 189.6 kg ha^{-1}, P_2O_5 15.0 kg ha^{-1} and K_2O 185 kg ha^{-1}. In paired row sowing method two pairs of rows were spaced at 30 cm apart and within the pairs the rows were spaced at 20 cm along with plant to plant distance maintained at 10 cm. In criss-cross method, the first half of the seeds were sown in one direction adopting recommended row to row spacing of 20 cm and the remaining half was sown at 90° to the original direction by adopting the same row spacing (20 cm). Bold and healthy groundnut seeds were treated with captan @ 2 g kg^{-1} seed. The groundnut variety 'Smruti' was sown in first fortnight of July during all the experimental years with plant spacing of 30 x 10 cm^2 on flat beds. N,P and K were applied @ 20, 40 and 40 kg ha^{-1}, respectively, in the form of urea, single super phosphate and muriate of potash. Gypsum @ 250 kg ha^{-1} was also applied uniformly. The entire quantity of fertilizer was applied at sowing time in furrows opened 5 cm away from the seed line and later furrows were covered with soil, except gypsum which was applied at 21 DAS. The inter-cultivation and hand weeding were carried out as per the treatment details. Randomly five plants were selected from each plot and regular biometric observations of various crop parameters recorded from 40 DAS upto harvest. For economic study, prevailing market price was used for different outputs and inputs. This was worked out by taking the components of labour, cost of various inputs used time to time as well as cost of tillage and sowing method treatments. All the data were subjected to analysis of variance (ANOVA) as per the standard procedure.

RESULTS AND DISCUSSION

Growth analysis

Tillage practices influenced the number of root nodules at 40 and 80 DAS and number of pegs plant^{-1} significantly. Highest root nodules at 40 and 80 DAS as well as number of pegs plant^{-1} was observed under rotavator tillage, which was significantly higher than zero tillage and conventional tillage. It might be due to higher soil pulverisation and better root growth in rotavator tillage treatment which developed the better crop canopy (Rabo and Ahmed, 2013). Sowing methods also influenced the number of root nodules at 40 and 80 DAS and number of pegs plant^{-1} significantly. Highest root nodule at 40 and 80 DAS as well as number of pegs per plant was observed in paired row method of sowing, which was significantly superior over other sowing methods. However, the interaction effect between tillage and sowing methods was non-significant.

Yield attributes and yield

Tillage practices did not differ significantly in respect of yield of groundnut (Table 1). However, tillage practices differed significantly in respect of haulm yield and yield attributes (pods plant^{-1}, 100-kernel weight, shelling percentage and harvest index). Similar observations have been reported by Patil *et al*. (2010). These findings differ from those of sowing methods which significantly affected pod and haulm yield and yield attributes, except harvest index. The pods plant^{-1}, 100-kernel weight and shelling percentage were highest in paired row sowing method and significantly superior over other sowing methods (Table 2). The paired row sowing method gave significantly higher pod and haulm yield than other sowing methods. The paired row sowing method recorded 25.4% increase in pod yield over conventional method of sowing. Appropriate method of sowing has pest and disease and mechanical harvest. The paired row sowing method has the above advantages several advantages like better inter-culturing, weeding, uniform irrigation, management of insect, as compared to other sowing methods like seed-cum-fertilizer drill sowing, criss cross sowing and conventional sowing (Devi Dayal *et al*., 1992). However, the interaction effect between tillage and sowing methods was non-significant.

Economics of cultivation

Tillage practices did not differ significantly in respect of gross return, net return and B:C ratio (Table 3). Maximum gross and net returns were recorded in rotavator tillage while maximum B:C

Table 1: Dry pod yield and dry haulm yield of groundnut as influenced by tillage and sowing method

Treatments	Dry pod yield (kg ha^{-1})				Increase	Dry haulm yield (kg ha^{-1})			
	2010	2011	2012	Pooled	(%)	2010	2011	2012	Pooled
Tillage practices									
Conventional tillage	1667	1430	1496	1531	-	3348	2623	2414	2795
Zero tillage	1587	1491	1573	1550	1.2	2972	2494	2506	2657
Rotavator tillage	1604	1463	1642	1570	2.5	3149	2503	2627	2760
$CD_{0.05}$	Ns	29	52	ns		Ns	ns	336	ns
Sowing methods									
Conventional sowing (control)	1548	1268	1444	1420	-	3034	2139	2383	2519
Seed cum fertilizer drill	1569	1512	1541	1541	8.5	3122	2690	2480	2764
Paired rows(20 cm/ 30 cm x 20 cm)	1915	1641	1787	1781	25.4	3458	2939	2752	3050
Criss cross (20 cm x 20 cm)	1444	1424	1509	1459	2.7	3012	2391	2448	2617
$CD_{0.05}$	204	64	60	77	-	326	256	390	153

Interaction between tillage practices and sowing methods was non-significant

Table 2 : Yield attributing parameters of groundnut as influenced by tillage and sowing methods

Treatments	Root nodules plant^{-1} (No.)		Pegs plant^{-1} (No.)	Pods plant^{-1} (No.)	Shelling (%)	100-kernel weight (g)	Harvest index (%)
	40 DAS	80 DAS					
Tillage methods							
Conventional tillage	24.4	93.2	28.3	21.7	62.9	29.9	35.7
Zero tillage	25.0	94.8	31.6	24.4	64.2	30.0	36.9
Rotavator tillage	26.5	97.7	34.0	26.4	65.9	32.0	36.5
$CD_{0.05}$	1.0	2.8	1.7	1.1	1.17	0.73	0.95
Sowing methods							
Conventional sowing (control)	21.0	90.3	28.3	21.7	63.6	29.1	36.2
Seed cum fertilizer drill	25.6	94.8	31.6	24.3	64.0	30.4	36.0
Paired rows (20 cm/ 30 cm x 20 cm)	29.7	103.7	35.1	27.6	66.6	33.6	37.0
Criss cross (20 cm x 20 cm)	24.8	92.0	30.2	23.1	63.0	29.2	36.2
$CD_{0.05}$	1.1	3.3	1.9	1.3	1.36	0.85	ns

Interaction between tillage practices and sowing methods was non-significant

*Sale price of groundnut pod @ ₹ 22.33 kg $^{-1}$;**Benefit:cost ratio ;a: ploughing by tractor

ratio was obtained in zero tillage. The sowing methods significantly influenced gross return, net return and B:C ratio. The paired row sowing method produced significantly more gross return (₹ 39662 ha^{-1}), net return (₹19730 ha^{-1}) and B:C ratio (2.0) than other sowing methods. This

Table 3: Economics of groundnut as influenced by tillage and sowing methods

Treatments	Cost of cultivation (₹ ha^{-1})*	Cost of treatment (₹ ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Gross return** (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio***
Tillage methods						
Conventional tillage	17613	2027^{a}	19640	34102	14462	1.74
Zero tillage	17613	1829^{b}	19442	34595	15153	1.79
Rotavator tillage	17613	2181^{c}	20394	35262	15468	1.78
$CD_{0.05}$	-	-	-	ns	ns	ns
Sowing methods						
Conventional sowing (control)	17613	1350^{d}	18963	31632	12669	1.67
Seed-cum-fertilizer drill	17613	2548^{e}	20161	34383	14222	1.71
Paired rows (20 cm/30 cm x 20 cm)	17613	2319^{f}	19932	39662	19730	2.00
Criss cross (20 cm x 20 cm)	17613	1856^{g}	19469	32935	13466	1.69
$CD_{0.05}$	-	-	-	1646	1562	0.08

Interaction between tillage practices and sowing methods was non-significant

*Cost of cultivation: i) Labour: 42 mandays @ ₹ 90/= manday^{-1} with manday with breakup as cleaning of field and bunds (5), seed treatment (2); shelling of pod and cleaning of kernels (10), crop irrigation (5), plant lifting from soil at harvest (10), drying, bundling, loading and unloading (4) and threshing ,winnowing, bagging and storing (6) = ₹ 3780/-, ii) Seeds: 175 kg ha^{-1} @ ₹ 30 kg^{-1} = Rs. 5250/-, iii) Manures: 5 t ha^{-1} @ ₹ 600 t^{-1} = Rs. 3000/-, iv) Fertilizers: N,P&K::20, 40 & 40 kg ha^{-1} @ ₹ 8, 21 & 12 kg^{-1}, respectively, = ₹1480/-, v) Gypsum application and seed treatment = ₹353/-, vi) Plant protection chemical including weedicide application ₹1950/-, vii) Irrigation charges (6 irrigations @ ₹ 300/= irrigation^{-1}) = ₹ 1800/-

**Sale price of groundnut pod @ ₹22.33 kg^{-1}; ***Benefit:cost ratio;

a) Ploughing by tractor For 4 hr ha^{-1} @ ₹ 506.75 hr^{-1}; b) ploughing only row zone tillage by tractor mounted zero till drill for 4 hr ha^{-1} @ ₹ 456.75 hr^{-1} ; c) ploughing by tractor mounted rotavator for 4 hr ha^{-1} @ ₹ 545.25 hr^{-1}; d) sowing manually at a plant spacing of 10 cm x 30 cm with 15 mandays ha^{-1} @ ₹90 manday^{-1}; e) sowing by tractor mounted seed-cum-fertilizer drill at a plant spacing of 10 cm x 25 cm with 20 mandays ha^{-1} @ ₹ 90 manday^{-1}for Rs 1800 and fuel costing ₹ 748 ha^{-1}; f) sowing groundnut seed manually in a paired row of distance 20 sm row to row within a pair and 30 cm distance between two paired rows with 25.76 mandays ha^{-1} @ ₹ 90 manday^{-1}; g) sowing seed manually in both the direction with a plant spacing 20 cm x 20 cm with 20.62 mandays @ ₹ 90 manday^{-1}.

corroborates with the findings of Devi Dayal *et al*. (1994). The interaction effect between tillage and sowing methods was non-significant.

On the basis of present study, it may be concluded that none of the tillage practices were effective though paired row sowing method gave 15.6, 22.2 and 25.4% more pod yield than seed-cum-fertilizer drill, criss cross sowing and conventional sowing method, respectively. This increase was supported by the improvement in yield attributes *viz.*, number of pegs (35.1) and pods (27.6) plant^{-1}, shelling percentage (66.6) and 100-kernel weight (33.6 g) as well as enhancement in profitability (₹19,730/-) in groundnut (Patil *et. al*., 2010). Groundnut has assured increased production under *rabi* season yet it is not grown n a very vast scale in Odisha. This is because of the fact that any systematic income and resulting net profit gain has never been placed before the farmers, so as to attract them to bring more area under groundnut. It is suggested that for getting healthy return from groundnut farming, sowing should be made on paired rows as this method has several advantages.

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